

Summary of the September 2011 Workshop to Identify Potential Synergies between Nuclear and Renewable Energy Opportunities

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Workshop Report at:

<http://www.nrel.gov/docs/fy12osti/52256.pdf>

Workshop's Purpose / Mission

The objective of the workshop was to assemble experts in nuclear energy and renewable energy to

Identify and prioritize potential synergies between nuclear energy and renewable energy / energy efficiency

Identify potential leveraging opportunities

Why?

Meeting the U.S.'s energy needs will be challenging especially if carbon emissions are constrained or domestic and / or non-traditional sources for transportation energy become more important. Synergies may lead to additional and better options.

Advantages/Challenges of Each Technology

Nuclear

Renewable

Low GHG emissions & Energy security – fuel needs can be met in the U.S.

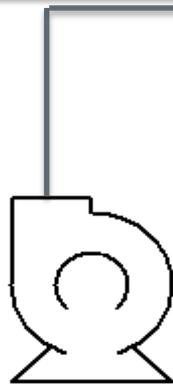
Advantages

- Proven, commercial technologies with ~20% market share and many potential improvements
 - Baseload power supply with very low fuel cost
 - High power density – small footprint
- Technologies gaining market share
 - Low to zero feedstock price volatility
 - Many of the technologies have the potential for distributed generation

Challenges

- Spent nuclear fuel
 - Concerns regarding potential accidents
 - High up-front capital requires high capacity factors & makes financing challenging
 - Long-lead times
 - Many designs have large water reqs.
- Intermittent and variable production leads to integration challenges
 - Levelized costs of some technologies need to be reduced
 - Siting is limited for some technologies leading to transmission challenges
 - Land area requirements can be challenging to meet

Workshop Structure



Pump primed with specific idea presentations

32 Attendees:

- 18 from National Labs
- 3 from DOE
- 1 from NRC
- 2 from White Sands Missile Range
- 1 from academia (MIT)
- 7 from industry (AREVA, CH2M Hill, Duke Energy, High Bridge Associates, Lifeboat Energy, TerraPower)

Brainstorm

Prioritize

Brainstorm

Identify

Prioritize

General Categories of Synergies

Specific Opportunities

Analysis & R&D Needs

Prioritized Set

Leveraged Needs

Workshop report to be public by December 9, 2011

Identified & Prioritized Opportunities

- Hybrid energy systems
- Value Proposition/Business case development
- Energy for transportation
- Lower priority opportunities
 - Balancing capacity on the grid / grid optimization
 - Islandable Micro-grids with Small Modular Reactors (SMRs) and renewable energy
 - Nuclear energy source for industrial applications
 - Lessons-learned
 - Permitting / licensing / financing / risk
 - Policy and institutional opportunities
 - Common R&D needs

Hybrid Energy Systems

Potential	<ul style="list-style-type: none">• Basis of a sound national energy policy with improved sustainability and energy security and without reducing quality of life.• Increase domestic energy production, which improves energy security and balance of trade ratios.
Challenges	<ul style="list-style-type: none">• Stovepipes between regulatory agencies for nuclear and renewable energies• Financing and risk assessment• Management
Priority Analysis Needs	<ul style="list-style-type: none">• Requirements definition• System design• Engineering components (effects of different generation services, intermediate carriers, storage systems, and tradeoffs with storage/service options)
Priority R&D Opportunities	<ul style="list-style-type: none">• Integrated, dynamic models• Pilot integration especially with disparate technologies• Enabling technologies such as energy storage, reactor design, energy conversion components, and interface components.

Value Proposition Development

Too many possibilities and questions to enumerate and describe the many business models.

Instead, focused on common issues

Potential	<ul style="list-style-type: none">• Expansive markets and huge potential
Challenges	<ul style="list-style-type: none">• Bold vision and strong leadership• Involvement of multiple stakeholder points of view• Technical difficulty• Engaging all stakeholders• High risk / quantification of risk
Analysis and R&D needs	<ul style="list-style-type: none">• Systems analysis (techno-economic, policy)• Quantification of the risks of the current energy system• Identification of the barriers to entry with the increasing complexity of integrated systems• Gap analyses looking at the build-out from current to the future state• Computational Tool Development• Energy management studies• Market acceptance studies

Energy for Transportation

Potential	<ul style="list-style-type: none">• Might improve cost competitiveness of biofuels and transform their potential from boutique fuels to viable alternatives to oil.• Converting to a biofuels-based transportations system would contribute to several national policy goals
Challenges	<ul style="list-style-type: none">• Same as hybrid systems• Developing economically feasible options for combining heat/power/hydrogen from nuclear facilities for generating fuels• Overcoming benefits of sunken capital in existing fuel infrastructure• Developing technologies to increase the density of biomass for transportation• Addressing concerns about nuclear safety
Priority Analysis Needs	<ul style="list-style-type: none">• Top-level systems analysis that includes what ifs, econometrics, customer input• Cost analyses for scenarios• Balancing plant scales and optimization.
Priority R&D Opportunities	<ul style="list-style-type: none">• Processes where all of the biomass is converted to biofuel instead of a large portion used for heat, electricity, and hydrogen• Processes that provide low cost hydrogen with a focus on nuclear processes• Energy crops with high energy-to-land densities

Conclusions & Path Forward

- High level of interest in the potential for synergies between nuclear, coal, and renewable hybrid systems
- A roadmap is needed that identifies:
 - Multiple options for hybrid systems
 - Tool, simulation, and modeling
 - Necessary assessments (risk, demand variability, etc.)
 - Gaps for R&D focus
 - Regional, national, and international opportunities and organizational needs
- Workshop Report at: <http://www.nrel.gov/docs/fy12osti/52256.pdf>

Supporting Slides

Workshop Presentations (1)

- U.S. Nuclear Power Policies and R&D Programs
 - Pete Lyons – Assistant Secretary for Nuclear Energy at DOE
- Nuclear/Wind/Hydrogen Systems for Variable Electricity and Hydrogen Production Synergies
 - Charles Forsberg – MIT
- Potential Role of Thermal Energy Storage
 - Paul Denholm – NREL
- Southeast Defense Energy Initiative
 - Ben Cross for Mike Navetta – SRNL

Workshop Presentations (2)

- Small Reactors for Energy Supply: Islanded Generation and Load Management
 - Philip Moor – High Bridge Associates
- Grid Scale Hybrid Energy Systems: Integrating Renewable and Nuclear Power
 - Richard Boardman – INL
- Non-Technical Considerations for Small Modular Reactors
 - Phillip Bond – White Sands Missile Range
- Small Modular Reactors – NRC Readiness for Licensing Reviews
 - David Matthews - NRC

Example Nuclear-Renewable Hybrid System

